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FINAL REPORT
TRADOC RAM DATA EVALUATION SYSTEM (TRADES)
(ACN 51235)

PART I: EXECUTIVE SUMMARY AND BRIEF

APJ 892-5

MILITARY & SCIENTIFIC
RESEARCH

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FINAL REPORT
TRADOC RAM DATA EVALUATION SYSTEM (TRADES)
(ACN 51235)

PART I: EXECUTIVE SUMMARY AND BRIEF

UNDER

CONTRACT NO. DAAK21-81-C-0034

FOR

RAM ENGINEERING AND ASSESSMENT BRANCH
RAM/ILS DIVISION
MATERIEL SYSTEMS DIRECTORATE
U.S. ARMY LOGISTICS CENTER
FORT LEE, VIRGINIA 23801

BY

AMERICAN POWER JET COMPANY

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FEBRUARY 1982

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER APJ 892-5	2. GOVT ACCESSION NO. AD-A13ᵇ 375	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) TRADOC RAM Data Evaluation System (TRADES)		5. TYPE OF REPORT & PERIOD COVERED Concept Development, Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) G. Chernowitz, J. Ciccotti, J. Arnold, R. Yoshikawa		8. CONTRACT OR GRANT NUMBER(s) DAAK21-81-C-0034
9. PERFORMING ORGANIZATION NAME AND ADDRESS American Power Jet Company 705 Grand Avenue Ridgefield, N.J. 07657		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 00910 Logistics 011700 Operations Research
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Logistics Center Materiel Systems Directorate (ATCL-MRS) Fort Lee, Va. 23801		12. REPORT DATE 5 February 1982
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Same as Item 11.		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Unlimited distribution.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

RAM, Reliability, Availability, Maintainability, Automation, Systems Development,
System Acquisition, R&M

TRADOC RAM Data Evaluation System

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The (TRADES) final report provides an innovative concept for the collection,
evaluation, storage, and dissemination of reliability, availability, and
maintainability data to satisfy TRADOC requirements. The five part study
recommends an automated system that enables the TRADOC combat developer to
access RAM information from appropriate data sources. Combat and materiel
developers need such a system to utilize and draw maximum actionable
inferences from existing and future data bases.

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Part I: Executive Summary. Includes the highlights of the study effort, detailing the background which led to the study, the essential areas of analysis, alternatives developed, study conclusions and recommendations.

Part II: Study Work Plan (SWP). The SWP outlines the objectives of the TRADES concept development, the purpose, assumptions, scope, essential elements of analysis, time schedule, and resources required for the study.

Part III: System Requirements Description (SRD). The SRD presents the functional requirements for the TRADES system developed using basic source documents, questionnaires, and dialogue established with data users, data proponents, and data sources.

Part IV: Alternative Concepts of Operation (ACO). The ACO explains the five ACOs which were developed and includes a comparative evaluation of these alternatives along with the recommendation to use the U.S. Army Logistics Center Planning Factors Data Base (PFDB) mini-computer.

Part V: System Technical Paper (STP). The STP documents the data system concept which includes the overall concept of operation, internal and external procedures, hardware and software requirements, and personnel implications. This report also recommends that TRADES capitalize on the currently available and programmed hardware within TRADOC, which significantly reduces implementation costs and time.

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POSITION, POLICY, OR DECISION UNLESS SO DESIGNATED
BY OTHER DOCUMENTATION.

PREFATORY NOTE

Force modernization and combat development requirements have greatly increased the demand for valid reliability, availability, maintainability (RAM) information. The scale and diversity of these requirements implies the requirement for the rapid data location, identification and analysis of RAM information. Moreover, extensive life-cycle management requires a RAM audit trail as the basis for ongoing materiel and combat development. This need is addressed by the TRADOC RAM Data Evaluation System (TRADES).

The American Power Jet Company (APJ) was responsible for concept development; this report covers requirement definition, assessment of alternative concepts of operation, recommended system operating characteristics, and resource requirements. Work was performed under Contract DAAK21-81-C-0034 and is documented in five parts.

The present volume (Part I) comprises an Executive Summary and a Brief of the detail material presented in the other Parts of this report. The first chapter is self-contained and comprises a short project summary, with further details provided in the other chapters. Analysis details incorporating the comments of the SAG, are submitted as Parts II through V.

This work was performed by the APJ project team comprised of G. Chernowitz, J.M. Ciccotti, J.E. Arnold, and R. Yoshikawa (BDM Corporation). Report editing, preparation and issue were capably handled by B. Boren, B. Cavallo, H. Wolf, and D. Heidt.

The extensive coverage of this study involved the cooperation of many individuals in TRADOC and Department of Army. We are particularly grateful to the representatives of the RAM data users and sources (in and out of TRADOC) who assisted our efforts, first with their response to our questionnaire and later in individual follow-ups.

We also express our appreciation to Mr. C.R. Lee, Technical Advisor to LOGCEN and Chairman of the Study Advisory Group (SAG), Mr. Richard B. Lindquist, RAM Engineering and Assessment Branch, Materiel Systems Directorate, Contracting Officer's Technical Representative, and the members of the SAG who contributed so substantially to the quality of our end products.

The final study report has been approved for distribution by the Logistics Center Commander as recommended by the SAG on 17 February 1982. The following organizations were represented on the SAG:

US Army Operational Test and Evaluation Agency,
Attn: CSTE-STS-M (Mr. French/Mr. Briggs)

US Army Training and Doctrine Command,
Attn: ATCD-SL (Mr. Johnson)

US Army Materiel Development and Readiness Command,
Attn: DRCQA-E (Mr. Nordstrom/Mr. Meese)

US Army Ordnance Center and School,
Attn: ATSL-CD-MS (Mr. Saponaro/Mr. Wadsworth)

US Army Armor Center and Fort Knox,
Attn: ATZK-CD-MS (Mr. Cundiff/CPT Mills)

US Army Signal School,
Attn: ATZH-CD-IL (Mr. Kidd)

US Army Air Defense Board*,
Attn: ATZC-D-T (CW2 Burgan/SFC Sowers)

US Army Field Artillery Board*,
Attn: ATZR-BD (LTC Gorham)

US Army TRADOC Combined Arms Test Activity,
ATTN: DCST&E (Mr. Smith)

US Army Logistics Center,
Attn: ATCL-TEA (Mr. Lee)
Attn: ATCL-OT (Mr. May)
Attn: ATCL-SSM (Mr. Lewis)
Attn: ATCL-MR (Mr. Demers/Mr. Lindquist)

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*Field Artillery Board replaced by Air Defense Board replaced by TRADOC Combined Arms Test Activity.

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THE PROBLEM

RAM Information Gap

Currently, TRADOC has no organized Reliability, Availability, and Maintainability (RAM) data system which provides quick access to the present-day myriad of data sources. When data are available, lack of uniform reduction procedures and specifics of the materiel test and field environment hampers the accurate statement of future materiel requirements.

Critical Event

This lack of key RAM information in the TRADOC community was highlighted during a 1 March 1978 briefing to the Commander, TRADOC. The Commander expressed concern as to how to establish RAM requirements on the Infantry Fighting Vehicle when the RAM performance of the current M113A1 personnel carrier was unknown. He noted that his staff had repeatedly tried to obtain RAM field data on the M113A1 without success. At his request, the LOGC was directed to try again to obtain M113A1 Field data.

Current Deficiencies Highlighted

Subsequent efforts provided test data from a wide variety of sources which exhibited large variances because of differences in environment, test purposes, and failure definitions used for test scoring purposes. Field data was extremely limited, poorly defined, and suffered from serious quality control problems. It became clear that an organized approach to TRADOC's RAM information requirements was necessary.

TRADES CONCEPT DEVELOPMENT

TRADOC Requirement

TRADOC requires access to RAM data for (1) the accurate statement of materiel requirements and other new equipment development actions, and (2) to establish procedures, techniques, and methodologies to support the total combat development mission, e.g., economic analysis, logistics support planning, budgetary planning, manpower determination, and simulations.

In February 1981, a contract was awarded to the American Power Jet Company (APJ) to develop a concept for TRADES as an in-house information system to access computer and manipulate available engineering, test, and field RAM data and provide these data in a proper format to support the user mission in materiel requirements development, operational and force development testing, and materiel acquisition.

APJ Contract

The study consisted of a series of investigations which are presented in this final report as:

1. Part I – <u>Executive Summary</u> and Brief (this report). Includes an Executive Summary and highlights the study's findings, conclusions, and recommendations.

2. Part II – <u>Study Work Plan</u> (SWP). An outline of the study objectives, assumptions, scope, essential elements of analysis (EEA), time schedule, and resource requirements.

Five Parts to this Study

3. Part III – <u>System Requirements Description</u> (SRD). Presents the TRADOC user requirements for the TRADES system, potential RAM data sources, and their content and accessibility.

4. Part IV – <u>Alternative Concepts of Operation</u> (ACO). Examines five alternatives for operation of TRADES, including merging TRADES with the Automatic Data Processing Equipment (ADPE) study, the Planning Factors Data Base (PFDB), the Maintenance Task Demand (MTD) file, and two versions of a stand-alone system. The recommended PFDB alternative was selected by the SAG for further development.

5. Part V – <u>The System Technical Paper</u> (STP). Provides further detail addressing the PFDB alternative to include internal and external procedures, hardware and software requirements, and personnel implications of the TRADES system.

TRADES Coordination with new Army data Systems

The development of TRADES is timely and coordinates with data systems becoming available to the Army. The Standard Army Maintenance System (SAMS) is scheduled for full implementation by 1984 and DARCOM's Common Test Data Collection System (CTDCS) is now in implementation. TRADES will provide the unifying mechanism to access data previously

unobtainable. The result will be an integrated and consistent treatment of RAM information with enhanced flexibility and ease of operation.

TRADES CONCEPT AND OPERATION

The TRADES system concept incorporates five basic modules:

1. Source Identification Module - central repository of RAM data sources in a logical organization of commodities, identifying the form of data, location, extent of holdings and definitions for all essential elements of information (EEI).

2. Interface Module - basic vehicle to provide for rapid, automatic interface with other data systems, such as Defense Technical Information Center (DTIC), SAMS, CTDCS, Common RAM (COMRAM), and Logistics Support Analysis Record (LSAR)

Five
Operating
Modules

3. Statistical/Analytical Module - a series of "tools" to reduce raw data to a form usable by the RAM engineer.

4. Quick Response Module - provides immediate "expected" value for each EEI by item identification, environment and life cycle stage (controlled by the item proponent).

5. Management Module - provides the TRADES Management Branch the ability to monitor usage, update other modules, maintain historical records, and provide control over the TRADES process.

The five basic TRADES system modules are illustrated in Figure 1-1. Application of these modules in a request flow diagram is illustrated in Figure 1-2.
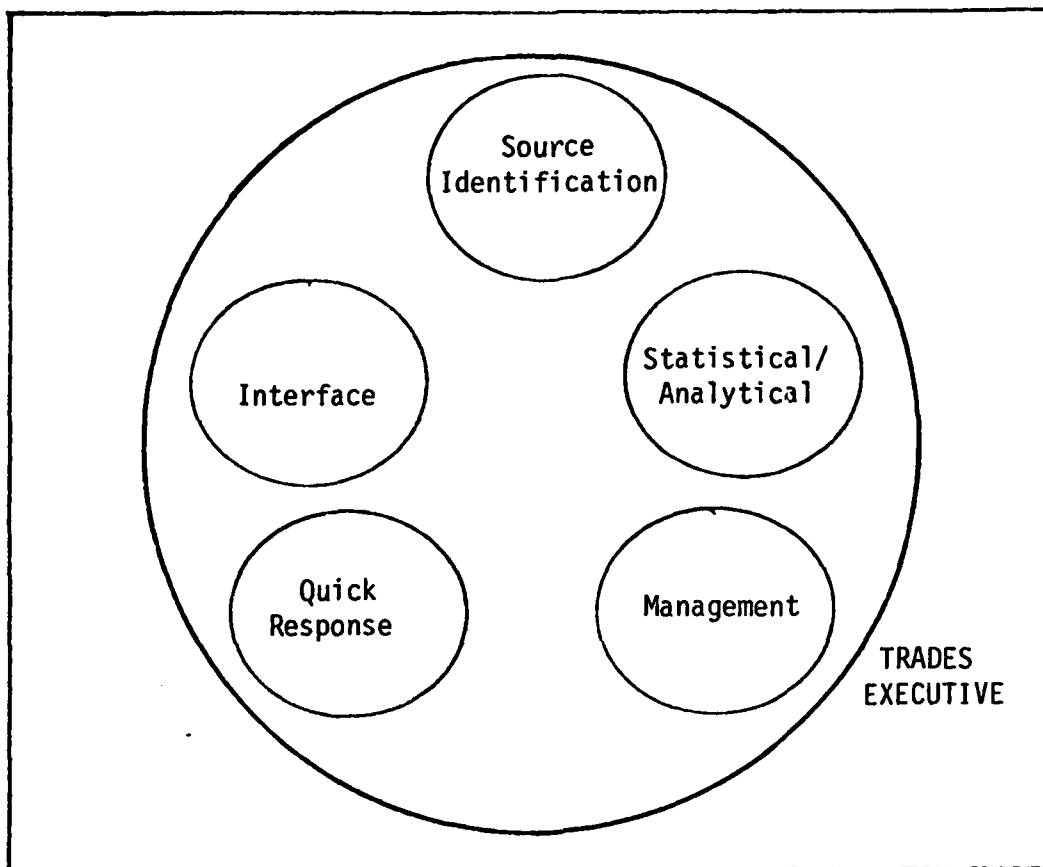
Figure 1-1. TRADES System Concept Module
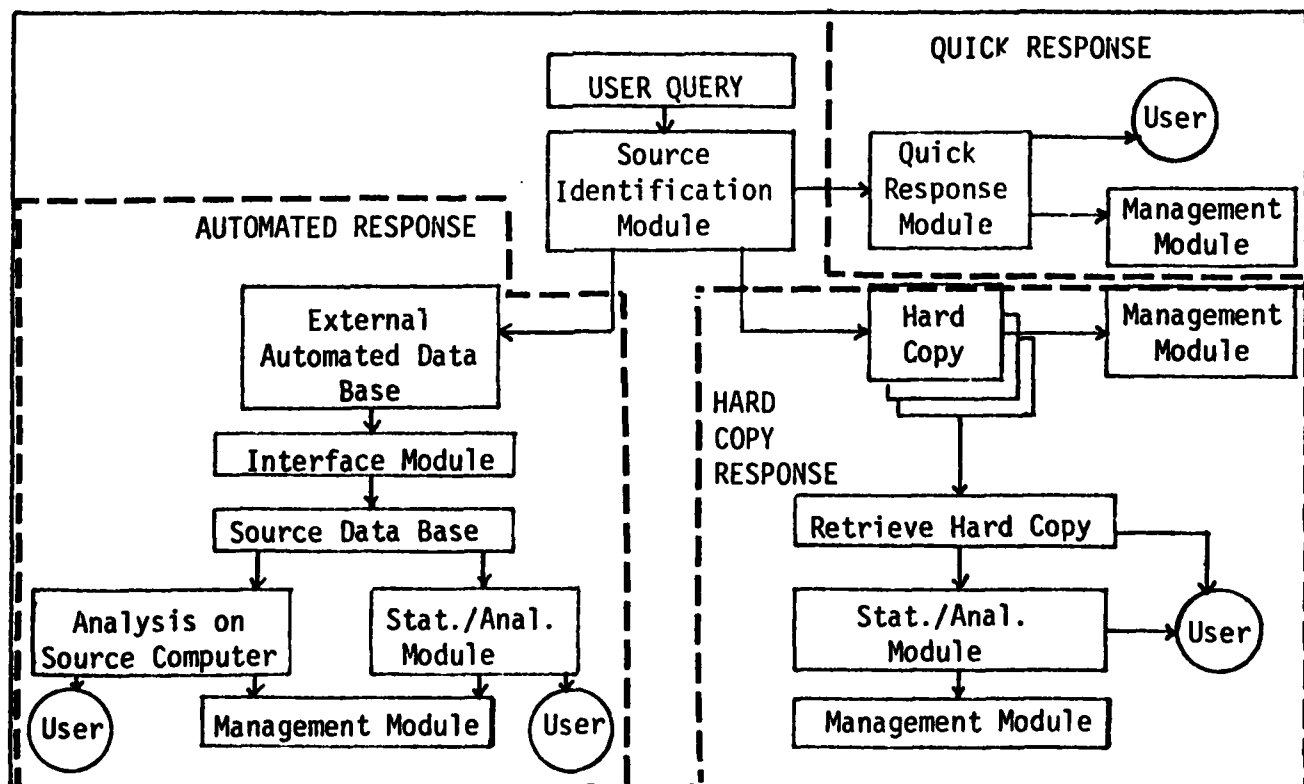
Figure 1-2. TRADES Request Flow

The <u>Source Identification Module</u> provides the initial point of contact for the user query. At this point, the user can decide to extract the "expected" (working) value from the <u>Quick Response Module</u> or develop RAM data sources in external automated data bases or from hard copy. Where information is available in an external automated data base, the <u>Interface Module</u> provides the necessary software to access the source system and extract the required data.

Description of Modules

The <u>Statistical/Analytical Module</u> can be used for both hard copy and automated data base analysis. A series of procedures are available which the user can select to manipulate and format the information to satisfy his requirements.

The <u>Management Module</u> is used to record frequency of uses, results derived, and other information considered desirable for management purposes. Additionally, it provides a history file to maintain an audit trail of RAM analyses.

RESOURCE REQUIREMENTS

Use of Existing/ Planned Capabilities

The TRADES concept has been developed to maximize use of "sunk" costs in equipment and software by integrating TRADES with the PFDB program by using computers already on hand or programmed for Fort Lee and Fort Leavenworth. Additionally, TRADES will only require additional terminals and some peripheral equipment. The generic system configuration of the TRADES concept in PFDB is shown in Figure 1-3.

Incremental Resources

Incremental cost will include the requirement for a limited number of terminals and a total of 16 additional personnel, six in a TRADES Management Branch, one to supplement the present data processing element in the LOGC, and nine general engineers to supplement the present RAM engineers at the TRADOC schools that indicate workloads in excess of present personnel assignments. The increase in personnel would enable TRADOC activities to more fully address, in conjunction with TRADES, all systems for which they are the proponent or the logistics oriented school (LOS).
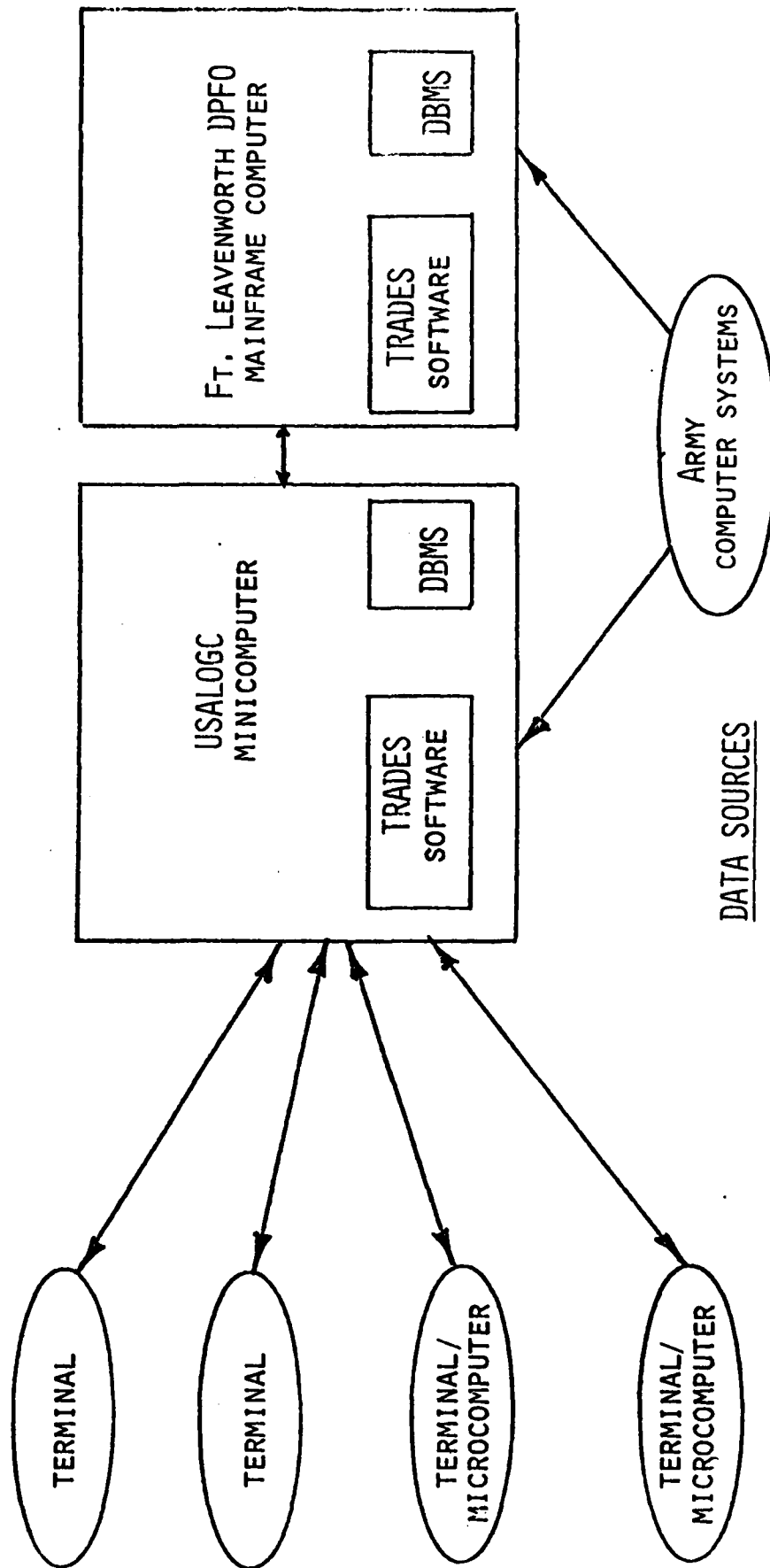
Figure 1-3. Generic TRADES System Configuration
(Automated Portion)

Incremental Costs

It is projected that the marginal costs of development of the PFDB TRADES concept will approximate $600,000 exclusive of additional personnel. This classifies TRADES as a Class IV ADP system which will require a Project Officer appointed by TRADOC, with system approval at TRADOC level.

Implementation

It is projected that TRADES can be implemented during 1985 in accordance with the TRADES life cycle overview provided in Figure 1-4.

PRIMARY CONCLUSIONS & RECOMMENDATIONS

TRADES Life Cycle Management

TRADOC Can Approve

Conclusion 1: TRADES is a viable concept. Although TRADES will not require DA level approval (developmental costs are anticipated to be less than $3M), AR 18-1 functions as an umbrella over all Army automation management. Therefore, the provisions of this regulation must be recognized and development actions for TRADES must be within the parameters of this regulation.

Initiate Developmental Actions

Recommendations: Initiate appropriate life cycle management actions to expedite system development in accordance with AR 18-1 and TB 18-100. These actions include:

a. Appoint a Project Officer (PO) for TRADES.

b. Prepare a charter which contains the specific authority and responsibility of the PO for getting the system developed and deployed.

c. Develop a Management Plan (MP) within 120 days of appointment of the PO.

d. Designate the RAM/Integrated Logistic Support (ILS) Division of the U.S. Army Logistics Center as the Functional Proponent (FP) and Proponent Agent (PA) for TRADES for functional development of TRADES.

o AR 18-1 (Army Automation Management) STAGES:

PHASE	FEASIBILITY I	CONCEPT DEVELOPMENT II	DEFINITION/DESIGN III	SYSTEM DEVELOPMENT IV	DEPLOYMENT OPERATION V	MATURE SYSTEM
Function	Determination of Need	ACO Evaluation -- Functional Description	Information Organiz'n. -- System Design -- Prototype	Program -- Debug --	Initial Use -- Full Scale Implementation	Update -- Modifications -- PIP
			NEXT STEPS			
Status	Completed	Completed				

o TRADES:

PROTOTYPING	△ Manual/Initial Automation
AUTOMATION	System Programming

1982   1985+

Figure 1-4. TRADES Life Cycle Overview

e. Designate the Planning Factors Management Division (PFMD) of the Logistics Center as Assigned Responsible Agency (ARA) for technical development of TRADES. This includes responsibility for production of the ADP software that automates the functional system.

f. Conduct an economic analysis for review at Milestone I.

g. Initiate a System Decision Paper (SDP) to formalize completion of the Concept Development Phase of the TRADES automation life cycle.

h. Initiate a functional description which would go to the level of detail previously equatable to the Detailed Functional System Requirements (DFSR).

Management Tasks

Initiation of Management Actions

Conclusion 2: Other management actions must also be taken to ensure continuity of the TRADES development process.

Recommendation: Initiate other management tasks necessary for the TRADES development process:

a. Organize a TRADES Management Branch during FY 1983. This branch would assume functional responsibilities of the PM when organized.

b. Prepare an Army regulation to support data requirements and management responsibilities for the formalization of TRADES.

c. Take full advantage of sunk costs by LOGC and TRADOC in the programming and implementation of TRADES.

d. Plan an implementation date of early 1985 to adopt the developed TRADES System.

e. Plan necessary personnel augmentation to proponents.

Software

Conclusion 3: TRADES is designed to take maximum advantage of state-of-the-art Data Base Management Systems (DBMS) and languages. Commercial DBMS should be used. TRADES should minimize new software development to the extent possible by using PFDB common software and language.

State-of-the-Art Software

Recommendation: The use of high order languages should be investigated to reduce post-development software support. TRADES software should achieve, to the extent possible, maximum ease of use of the capabilities of TRADES.

Hardware

Conclusion 4: The system is planned to capitalize on the latest available hardware. System design is flexible enough to ensure that technological improvements to hardware are not detrimental to TRADES. Maximum use is made of "sunk costs" of hardware already on hand or programmed.

Utilization of Existing/Planned Hardware

Recommendation: Expanded analysis capability at the user level through distributed micro-computers is actually an enhancement of TRADES, and will provide greater capability without duplicating the source identification and data storage capabilities of TRADES. Updating these files, in fact, would be facilitated through the use of micro-computers where the volume of data becomes sufficient to justify the cost.

SECONDARY CONCLUSIONS & RECOMMENDATIONS

Hard Copy Development

Conclusion 5: The evolutionary development of TRADES may most effectively be undertaken by taking steps to avoid the continued loss of RAM data, and to address the problems of hard copy retention, identification, assessment and organization.

Need to Retain/Assess/Organize Hard Copy

Recommendation: Initiate a limited data collection effort to determine, as rapidly as possible, the extent, location and accessibility of the TRADOC hard copy RAM information. This task could be done in conjunction with prototyping to verify the taxonomy and data extraction procedures for TRADES.

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Prototyping

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Conclusion 6: An inherent characteristic required of TRADES is that it be capable of being prototyped and permit its evolution in the direction of maximum customer service. RAM information is not a "once and for all" requirement set by current RAM requirements documents or users, but are only starting points.

Recommendation: Prototyping is recommended for verifying interface procedures, exercising manipulation and analysis routines, initiating a program for development of the "hard copy" data, and verifying the categorization or taxonomy technique of the RAM data.

Further, it is recommended that prototyping of TRADES be initiated with a commodity area/activity which is a current major repository of RAM data, so that the entire system may be exercised and lessons learned applied to create a successful TRADES.

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TRADOC Test Data System

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Requires
that
TRADOC
Test Data
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Conclusion 7: There is currently no common automated system within TRADOC to capture raw data from tests performed within TRADOC. There is a requirement that these test results be an integral part of TRADES and available on an interactive basis, particularly during the conduct of tests and to maintain an audit trail of past efforts.

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Recommendation: Investigation should be made to examine the development of an exclusive RAM test data system for use by TRADOC activities.

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Portability

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Conclusion 8: There are advantages to the common location of OAD and the TRADES functional activity at the same installation, and there is substantial advantage to begin the operation with a mini-computer. Nevertheless, it is also a requirement that the system be "portable", i.e., that the programs and logic not be computer-peculiar or linked irrevocably to another system.

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Recommendation: Specific attention should be given to insure that TRADES remains portable in its design and development characteristics so that it is not bound to one specific set of hardware.

BACKGROUND

Increasingly sophisticated materiel acquisition and combat developmental processes are being initiated by the U.S. Army. As a consequence, TRADOC has a requirement for better RAM information to assist in establishing materiel requirements, forecasting manpower authorization criteria, inputs to simulations, war games, testing comparisons, cost and effectiveness analyses (COEA), and budgetary planning.

Recent Department of Army initiatives in the RAM arena have expanded demands on the TRADOC RAM engineers. These changing responsibilities are highlighted in AR 702-3 (Draft), "Army Materiel Reliability, Availability, and Maintainability", currently being staffed. TRADOC responsibilities for RAM are set forth as follows:

1. Establish controls for RAM compliance.

2. Determine realistic RAM requirements.

3. Monitor RAM performance in development test (DT) and operational test (OT).

4. Establish liaison with materiel developers to assist exchange of RAM data needed for emerging systems.

5. Maintain a central activity for proper statement of RAM in materiel requirements documents.

6. Develop RAM methodology vis-à-vis combat developments.

7. Conduct OT to assess RAM.

8. Review requests for RAM waivers.

9. Provide RAM training for combat developers.

The basic purpose of TRADES is to provide the TRADOC RAM engineer in the combat development area with the tools to do the required job. The methodology used for its development followed a systematic approach to identify TRADOC user requirements and develop

alternative concepts to satisfy the requirement. The overall TRADES methodology map (Figure 2-1) portrays the major steps taken.

ESTABLISH SYSTEM
REQUIREMENTS DESCRIPTION

To prepare the System Requirements Description (SRD), several major actions were performed:

1. A literature search included key regulatory documents from DoD, DA, and TRADOC, as well as extensive research into related RAM information and documents.

2. Two comprehensive questionnaires* helped determine RAM requirements and data sources.

   The first was sent to all expected users of TRADES, primarily the TRADOC community, and other agencies, such as HQ DA, TRADOC, and the Logistics Evaluation Agency. The purpose of this questionnaire was to establish a baseline of user needs, present sources, and availability/satisfaction of RAM data.

   A second questionnaire addressed potential data sources. Information was requested on the source RAM data base's automated or hard copy, extent of RAM holdings, accessibility, methods of retrieval, and normal customers supported.

3. Visits were made to key data users and sources to follow-up on questionnaire responses and to elaborate on required TRADES characteristics. Visits were made to DA, DCSLOG, DCSRDA, HQs TRADOC, U.S. Army Transportation School, U.S. Army Training Support Center, U.S. Army Quartermaster School, Logistics Evaluation Agency, HQs DARCOM, Materiel Readiness Support Activity, U.S. Army Central Test Measurement and Diagnostic Equipment Activity, U.S. Army Quality Arsurance Field Activity, U.S. Army Materiel Systems Analysis Agency, U.S. Army Ordnance Center and School, PM SMOKE, U.S. Army Mobility Equipment Research and Development Command, U.S. Army Engineer School, U.S. Army Operational Test and Evaluation Agency, and U.S. Army Test and Evaluation Command.

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*See Part III, SRD, for questionnaire contents and explicit results.

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              │  SYSTEM REQUIREMENTS │
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  │   ANALYSIS     │                             │
  │    (EEAs)      │                             │
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  │  COMPARATIVE   │                   │      OF          │
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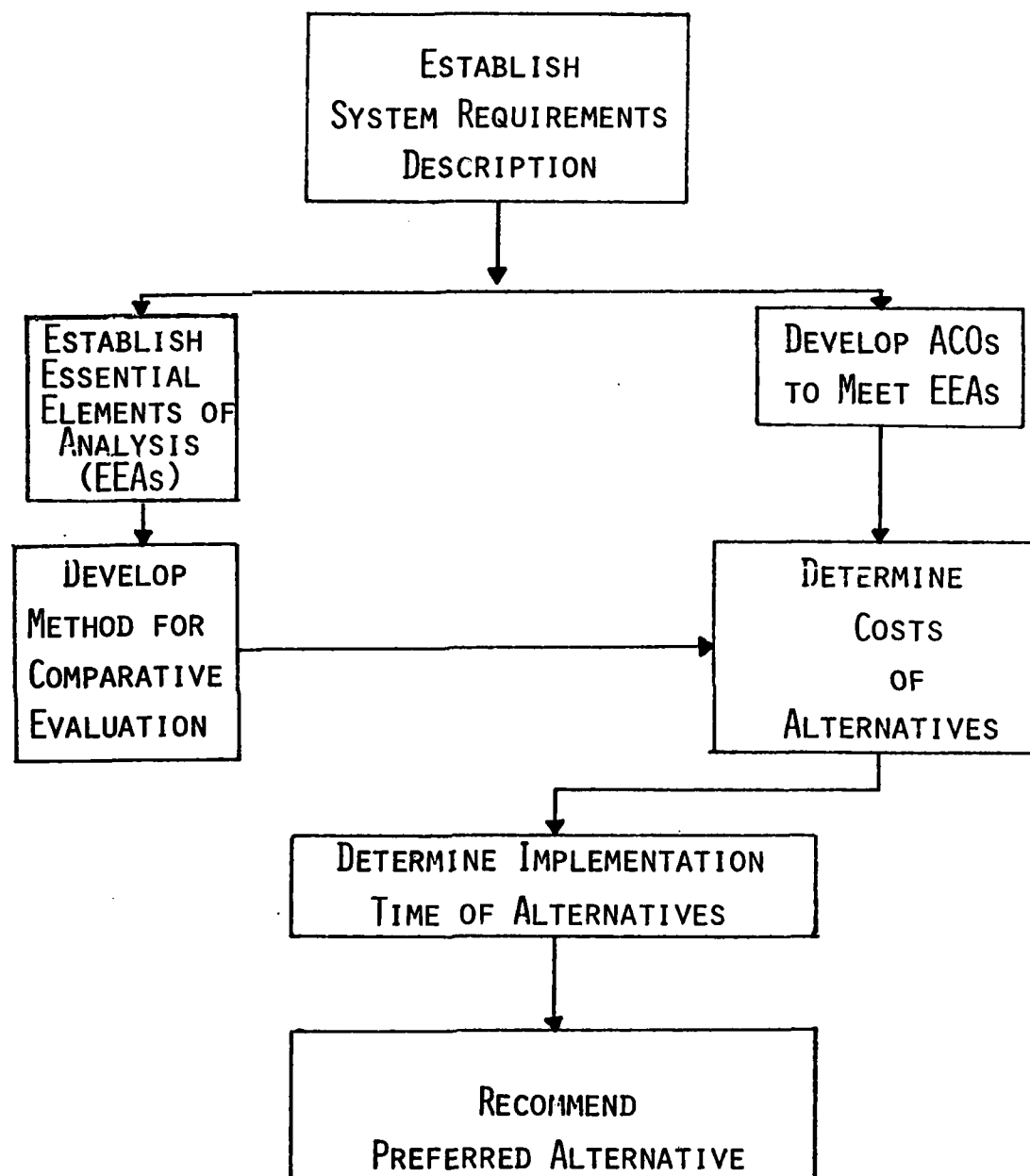
Figure 2-1. TRADES Methodology Map

These visits yielded valuable insights into the procedural aspects and availability of RAM information. The immense variety of sources and form of data available became apparent, and underscored the need for a unified RAM evaluation system.

ESSENTIAL ELEMENTS OF ANALYSIS (EEAs)

The following EEAs were established to evaluate the various alternatives:

1. Responsiveness to TRADOC user requirements

2. Accessibility to proponents

3. Essential Elements of Information (EEIs)

4. Flexibility (batch vs interactive)

5. Integration with other systems

6. Backup capability

7. Growth potential

8. Quality control

9. Security – software and data base

10. Implementation time

11. Resource requirements:

   a. Investment
   b. Operating

ALTERNATIVE CONCEPTS OF OPERATION (ACO)

It was necessary to develop a methodology for comparing the alternatives developed. Of the available techniques, it was considered most advantageous to develop alternatives that would satisfy the EEAs previously described, and then measure the resulting differences in resource requirements and implementation time implied by each approach.

This chapter summarizes the system requirements for
TRADES, documented in the System Requirements Des-
cription (SRD), Part III of this report*.

TRADES OBJECTIVES

The basic purpose of TRADES is to provide a system
that TRADOC and its materiel proponents can use to
locate, identify, collect, analyze, validate, store,
retrieve, process and disseminate RAM information
using units of measure and methods of presentation
compatible with TRADOC proponent requirements.
Furthermore, TRADES must be able to satisfy user
requirements in a timely manner and within realis-
tic availability of information provided by RAM data
sources.

Thus, TRADES provides an interface and analysis sys-
tem facilitating the exchange of information be-
tween RAM sources and RAM data users. The follow-
ing provides a description of system characteristics
requirements used as the basis for developing ACOs
(Part IV of this report).

RESPONSIVENESS TO TRADOC
USER REQUIREMENTS

The TRADES functional requirements to satisfy the
TRADOC users were addressed from five key aspects:

1. Turnaround time requirements

2. Level of data required

3. Data form

4. Statistical and analytical manipulation

5. Application of defined factors to modify RAM data.

TRADES system requirements presented below were de-
veloped from the responses received from user ques-
tionnaires covering each subject area.

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*Data source characteristics are extensively covered in
Part III.

At the outset, it was determined from the question-
naire replies that user needs are such that recurring
reports are not appropriate. Rather, outputs tailored
specifically to user requests as to materiel scope
and detail are required. Certain reports needed for
TRADES management may, however, be required on a re-
curring and fixed format basis.

TURNAROUND TIME
REQUIREMENTS

When a requirement exists for RAM data, 24% of all
respondees require the information in less than one
week. An additional 32% (for a total of 56%) require
RAM data within one month of the time the request is
initiated. Further, research also revealed a re-
quirement for extremely rapid retrieval and verifica-
tion (less then 24 hours) in preparation for major
decision reviews.

To be responsive to the user's requirement, TRADES
must therefore be interactive, capable of responding
to urgent requirements as well as routine requests.

RAM DATA FORM

94% of all TRADOC users require field experience re-
duced data. 83% require field experience data based
on user mission. 83-94% require test data in some
form. 89% need data from specification and require-
ments documents.

QUICK RESPONSE
CONSIDERATIONS

Responses to user questionnaires, verified by on-site
interviews at selected activities, indicate a scar-
city of RAM data to satisfy specific user require-
ments for many of the older equipments now being re-
placed. As new equipment is developed, early data
is often of limited value in predicting life cycle
RAM.

Based on this, there is a requirement to establish an "expected value(s)" for applicable RAM data elements on items of Army materiel of interest to TRADOC proponents. Such expected values (properly identified and with appropriate caveats) could be used in lieu of a substantiated data base and refined as additional data become available.

ACCESSIBILITY TO PROPONENTS

Less than 50% of the user responses indicated the present availability of a terminal within their activity. However, within the present state of technology and cost, terminal purchase involves a minor commitment of resources.

ESSENTIAL ELEMENTS OF INFORMATION (EEI)

A total of 33 EEIs were developed from the user questionnaires. These EEIs satisfied the requirements of AR 702-3, the RAM Rationale Annex Handbook, as well as other reliability requirements. Of this total, the nine central requirements indicated by the user activities may be summarized as follows:

1. Reliability:

    a. Mean Time between Failures (MTBF)
    b. Mean Time between Operational Mission Failures (MTBOMF)
    c. Mean Time between Unscheduled Maintenance Actions (MTBUMA)
    d. Probability of mission success.

2. Availability:

    a. Operational availability/system readiness objectives
    b. Utilization rates

3-3

3. Maintainability:

    a. Mean time to Repair (MTTR)
    b. Maintenance ratio
    c. Logistic downtime.

It has been suggested that these nine EEIs be used to initialize the TRADES system. However, TRADES is designed with the capability of satisfying all user EEI requirements as part of its maturing process.

FLEXIBILITY

The anticipated workload of the TRADES system permits a consideration of batch processing. However, because of the responsiveness required of the system, TRADES must be flexible enough to provide for interactive capability.

INTEGRATION WITH OTHER SYSTEMS

TRADES has the function of interfacing with RAM data sources and repositories of related information.

The wide diversity of ADP equipments and systems used in such systems results in significant differences in programming languages, machine interface characteristics, etc. TRADES must provide adequate guidance to its users to permit entry and use of the different software packages and hardware systems.

BACKUP CAPABILITY

Backup capability to the TRADES system is provided at three levels:

1. A TRADES office within USALOGC

2. Use of expected values described above

3. Hardware backup of LOGC by DPFO.

HARD COPY/AUTOMATED ENVIRONMENT

The ultimate goal of the overall program is to establish a major RAM information system that will satisfy user requirements in minimum response time.

It must be recognized, however, that for several years, the system will be operating in a mixed hard copy environment which is only lightly automated, and moving toward a state where hard copy is less important than automated data. In either case, hard copy must be recognized as being involved in RAM data somewhere in the system at all times.

A major issue to be resolved is the disposition to be made of existing and newly generated hard copy data. One approach might be to leave it in its present physical location, with provisions to keep it from being destroyed until it is no longer useful to RAM analyses.

An alternative would be to maintain a central TRADES repository of all hard copy not formally inventoried in major hard copy data holdings with instructions issued for these holdings to be forwarded to the central repository.

The third concept would be to provide current organized data systems. (e.g., DTIC/Defense Logistics Services Information Exchange (DLSIE)) with the opportunity to index and inventory all holdings not currently in their files.

On the basis of the above, the development of the Source Identification Module would include major tasks of:

1. Indexing existing hard copy reports into the TRADES Source Identification Module.

2. Providing adequate information for each of the source documents (hard copy reports) that will provide the potential user with adequate information to determine the usefulness of each test report to his requirement.

3. Enter extracted key RAM reference data into the TRADES system, thereby reducing response time and narrowing the degree of hard copy search.

DATA SOURCES

The initial repository of RAM data in TRADES will be heavily weighted by the volume of test data available through TECOM, OTEA, TRADOC Schools, Centers and Boards, and the PMs' Offices (both TRADOC and DARCOM Managers). Current plans for a full-scale implementation of CTDCS and SAMS-1, 2, and 3, plus wholesale SAMS, provide a basis for large-scale introduction of automated RAM data bases into TRADES in the 1983-1985 timeframe.

GROWTH POTENTIAL

TRADES should have a growth potential to absorb intelligence from the major data systems noted above, as well as growth in the software packages to allow users to extract RAM data in a form to support the RAM engineers in their functions.

The TRADES software packages should be modular in concept, using the concept of master or executive program for identification and call-up of required modules suitable for a particular user application. The Interface Module can be modified to accommodate additional data systems and data bases, and each other functional module of TRADES must be designed for ease of modification and growth (structured programming).

It is essential that provisions be made for quality control of all input data with both edit and validity checks to be made periodically as update procedures are applied. Quality control provisions especially apply to expected values.

SECURITY OF SOFTWARE AND DATA BASE

Although TRADES is user-oriented, it is essential that security be maintained on pre-packaged software modules and the data base itself. Since users will have access to the data base for identification of RAM data sources, any changes, updates, edits, corrections, etc., should be performed by a function centralized within the TRADES Office. TRADES system changes by activities outside the TRADES Office would risk confusion and error.

This security should not, however, prevent the application of software modules for manipulation and analysis of data elements which are drawn into the TRADES system from external sources. Techniques and procedures are available within the current state-of-the-art to permit such manipulations to be performed external to the data base itself, so that the data base remains intact for other users.

Access security should be maintained by appropriate password and identifiers.

Security of classified data may be maintained by use of secure lines and (as required) encipherment and scrambling.

IMPLEMENTATION TIME

Selected alternatives need to be measured in terms of total forecasted implementation time. These times, along with resource requirements, are instrumental in the selection of a proposed alternative.

RESOURCE REQUIREMENTS

Total resource requirements for application of TRADES can best be measured by the relative volume of demands anticipated for TRADES.

Each of the selected potential TRADES users were queried as to the frequency of their RAM data requirements. Based on their responses, extrapolated to the total TRADOC community, it is forecast that an average daily demand of 75 requests will be made against a mature TRADES system, or a total of 20,000 actions per year by the TRADOC community. Early indications from interviews with DARCOM activities indicate at least a parallel requirement from the DARCOM PMs and test agencies. This implies a total annual demand of approximately 40,000 requests on TRADES, or 160 per day.

Consideration must be given to hardware, software, and personnel costs, based on the above indicated workload. (It should be noted that this projected workload is used throughout the STP (Part V) for determining requirements.)

GENERAL

The alternatives considered are explained in detail in the ACO, Part IV to this final report. These alternatives were:

1. Planning Factors Data Base (PFDB) - is currently under development by the LOGC. This alternative would feature time-sharing process with a LOGC minicomputer (to be selected) with back-up performed by the large mainframe (UNIVAC 1100/82) at DPFO. The connecting link with TRADES is that PFDB currently acts as a unifying umbrella over a number of other logistic systems at the LOGC.

2. Maintenance Task Demand (MTD) - is a system currently operating at DPFO with the LOGC as executive agent. There are a limited number of weapons systems on MTD at present, and less than 5% of the automated data entries are estimated to be the same as those projected for TRADES.

3. Automatic Data Processing Equipment (ADPE) - was an overall analysis of LOGC ADPE requirements. This alternative implied that TRADES time-share on a minicomputer with LOGEX. The major disadvantage of this system is the non-availability of the computer during the LOGEX annual training exercise, as well as the minimal relationships between LOGEX and TRADES subject content.

4. Stand-Alone Minicomputer (SAMI) - essentially considers a separate system (similar to PFDB) without, however, any relationship to any other system.

5. Stand-Alone Mainframe (SAMF) - envisions a single system located at DPFO, accessed on the same basis as the other systems, but not associated with any other system such as MTD or PFDB.

Table 4-1 compares the alternatives against the EEA set forth in the Methodology (Chapter II). In essence, there was little difference among the various ACOs, since the plan for each ACO was to create a nearly equal capability.

The estimated developmental cost comparisons (excluding school requirements for personnel) are shown in Table 4-2. Supplementary RAM engineers required by the various TRADOC schools and centers were not included as they reflect a constant element applicable to all alternatives.

Implementation Time

To properly assess this EEA, certain fundamental assumptions were accepted:

1. TRADES will be categorized as a Class IV ADP system per AR 18-1.

2. The MTD and SAMF ACOs, if selected, would be designed to reside on the UNIVAC 1100 Series ADP system at the TRADOC DPFO, Fort Leavenworth, Kansas.

3. The PFDB, ADPE and SAMI ACOs, if selected, would be designed to reside on the Operations Analysis Directorate (OAD) minicomputers planned for procurement and must have the DPFO available for backup for work overflow during peak work efforts.

4. The primary responsibility for operational support of TRADES will be assigned to an existing division/branch of LOGC as an additional function.

In general, implementation time for the PFDB, ADPE, and stand-alone ACOs should be equivalent. Since development effort for all ACOs will be in excess of $100,000 (but under $3M), they fall within a Class IV ADP, require a manager or project officer appointed by TRADOC, with system approval at TRADOC level.

TABLE 4-1.   ACO RELATIVE COMPARISONS

ESSENTIAL ELEMENTS OF ANALYSIS	PFDB	MTD	ADPE	SAMI	SAMF
RESPONSIVENESS					
Turnaround Time/Query Query Processing:					
-Hard Copy Response	*	*	*	*	*
-Auto. Data Avail. Response	*	*	*	*	*
Interface Module Proc. of Automatic Data Source:					
-Repor from Source	*	May be ltd. by Space Alloc.	*	*	May be ltd. by Space Alloc.
-Data from Source	**		**	**	**
-Data Processing on TRADES	**	**	**	**	**
-Output Formating	*	*	*	*	*
Stat./Anal. Module Processing:					
-Data from Automated Source	*	*	*	*	*
-Data Entry by User	**	May be ltd. by Port Access	**	**	May be ltd. by Port Access
-Output Formating	*	*	*	*	*
Quick Response Module Query	*	*	*	*	*
Management Module Processing:					
-Management Data Analysis	*	*	*	*	*
-Corporate Memory Stor./Process.	Limited by Capacity	May be ltd. by Space Alloc.	Limited by Capacity	Limited by Capacity	May be ltd. by Space Alloc.
Level of RAM Data Structure	*	*	*	*	*
RAM Data Form	*	*	*	*	*
Stat./Anal. Manipulations	*	*	*	*	*
Quick Resp. "Expected" EEI Values	*	*	*	*	*

*Meets TRADES requirement and equal capabilities have been provided.
**Meets Requirement

TABLE 4-1. ACO RELATIVE COMPARISONS (Concluded)

ESSENTIAL ELEMENTS OF ANALYSIS	PFDB	MTD	ADPE	SAMI	SAMF
QUALITY CONTROL					
Edit	*	*	*	*	*
Validation	*	*	*	*	*
SECURITY					
Software	*	*	*	*	*
Data Base	*	*	*	*	*
Classification	*	*	*	*	*
IMPLEMENTATION TIME (RELATIVE)	1.0	0.9	1.0	1.0	1.0
RESOURCE REQUIREMENTS $Cost:					
-Equipment	*	*	*	*	*
-Manning**	7 Add'l. Personnel	6 Add'l. Personnel	7 Add'l. Personnel	6 Add'l. Personnel	6 Add'l. Personnel
ACCESSIBILITY TO PROPONENTS					
Terminals	*	*	*	*	*
Telecon	*	*	*	*	*
EEIs	*	*	*	*	*
FLEXIBILITY					
Interactive	*	*	*	*	*
Batch Processing	*	*	*	*	*
INTEGRATION w/OTHER SYSTEMS (RAM data Sources w/ADP Systems)	*	*	*	*	*
BACKUP CAPABILITY	Uses DPFO as Backup	No Backup	Uses DPFO as Backup	Uses DPFO as Backup	No Backup
GROWTH POTENTIAL	L'td. to OAD/DPFO Capacity	L'td. to DPFO Capacity	L'td. to DPFO Capacity	L'td. to OAD Mini-Computer Capacity	L'td. to DPFO Capacity

*Meets TRADES requirement and equal capabilities have been provided. **Does not include additional school requirements.

TABLE 4-2. COST* SUMMARY OF ALTERNATIVES
($000)

DEVELOPMENT	PFDB	MTD	ADPE	SAMI	SAMF
Software	$400.0	$350.0	$400.0	$400.0	$400.0
Facilities	27.0	20.0	27.0	20.0	20.0
Hardware	192.6	184.3	192.6	192.6	184.3
TOTAL	$619.6	$554.3	$619.6	$612.6	$604.3
OPERATING (ANNUAL)					
Personnel**	$236.7	$200.0	$236.7	$200.0	$200.0
Facilities	1.5	1.3	1.5	1.3	1.3
Hardware	.7	10.8	.7	.7	10.8
TOTAL	$238.9	$212.1	$238.9	$202.0	$212.1

*1981 dollars; not rounded to preserve audit trail.
**Excludes additional school personnel.

In accordance with Table 4-3, TRADES could be implemented during calendar year (and fiscal year) 1985. Rigid adherence to the approval and administrative cycles is required in order to provide the software developer adequate time to complete the process. Software development incorporates system design to the level of programming, debugging, prototyping, and system demonstration.

TABLE 4-3. ACO COMPARISONS - TYPICAL IMPLEMENTATION
SCHEDULES

LIFE CYCLE STAGE	MTD	PFDB, ADPE, SAMI, SAMF
ACO Final Report	Feb. 1982	Feb. 1982
TRADOC Approval (Class IV System)	Aug. 1982	Aug. 1982
Date of Contract - Software Development	March 1982	March 1982
System Design & Development Completion	Dec. 1984	March 1985

The difference in implementation time for MTD is attributable to a minor savings of programming, debugging, and prototyping.

PFDB - THE SELECTED SYSTEM

The PFDB alternative was the system recommended by APJ, and agreed to by the SAG. The primary reason for the selection of the PFDB was the administrative support provided by the Planning Factors Division of the LOGC, and the high degree of relationship of PFDB with TRADES. (The cost and implementation time variances among alternatives were not significant enough to justify a clear choice based on those factors alone.)

ORGANIZATION AND LOGICAL
  STRUCTURE

The TRADES system concept envisions five modular
functional elements as shown in Figure 5-1. The
following descriptions of the modules serve the
purpose of exposition and demonstration, and do not
necessarily represent the file structure which will
be developed in the design phase of the TRADES life
cycle development process. The TRADES concept is
more fully explained in the STP, Part V to the
Final Report.

Module Descriptors

The Source Identification Module is a major element
of TRADES and will be the one most frequently ac-
cessed. Through the Source Identification Module,
the user will interactively query TRADES via a ter-
minal for the immediate determination of RAM data
information sources. Responses will include the ap-
propriate information (see Table 5-1) based on user
requirements.

After TRADES is initiated, information will be input
from test, field, or engineering sources. Where ap-
propriate, the item proponent may choose to enter an
expected value in the Quick Response Module (see
Table 5-2). In these cases, values are then immedi-
ately available to users in an immediate response
mode. Such values will be defined by mission, geo-
graphical conditions, and other appropriate modifiers.
Values in the Quick Response Module are controlled by
TRADOC proponents, and may be a calculated value from
the field or tests, or "expected" value based on a
process which is recorded in the associated qualifiers.

The Interface Module (Table 5-3) will provide for
rapid, automatic interface with other automated data
systems, such as DTIC, SAMS, COMRAM, CTDCS, and LSAR.
The development of these interfaces will require a
major proportion of the development and later, system
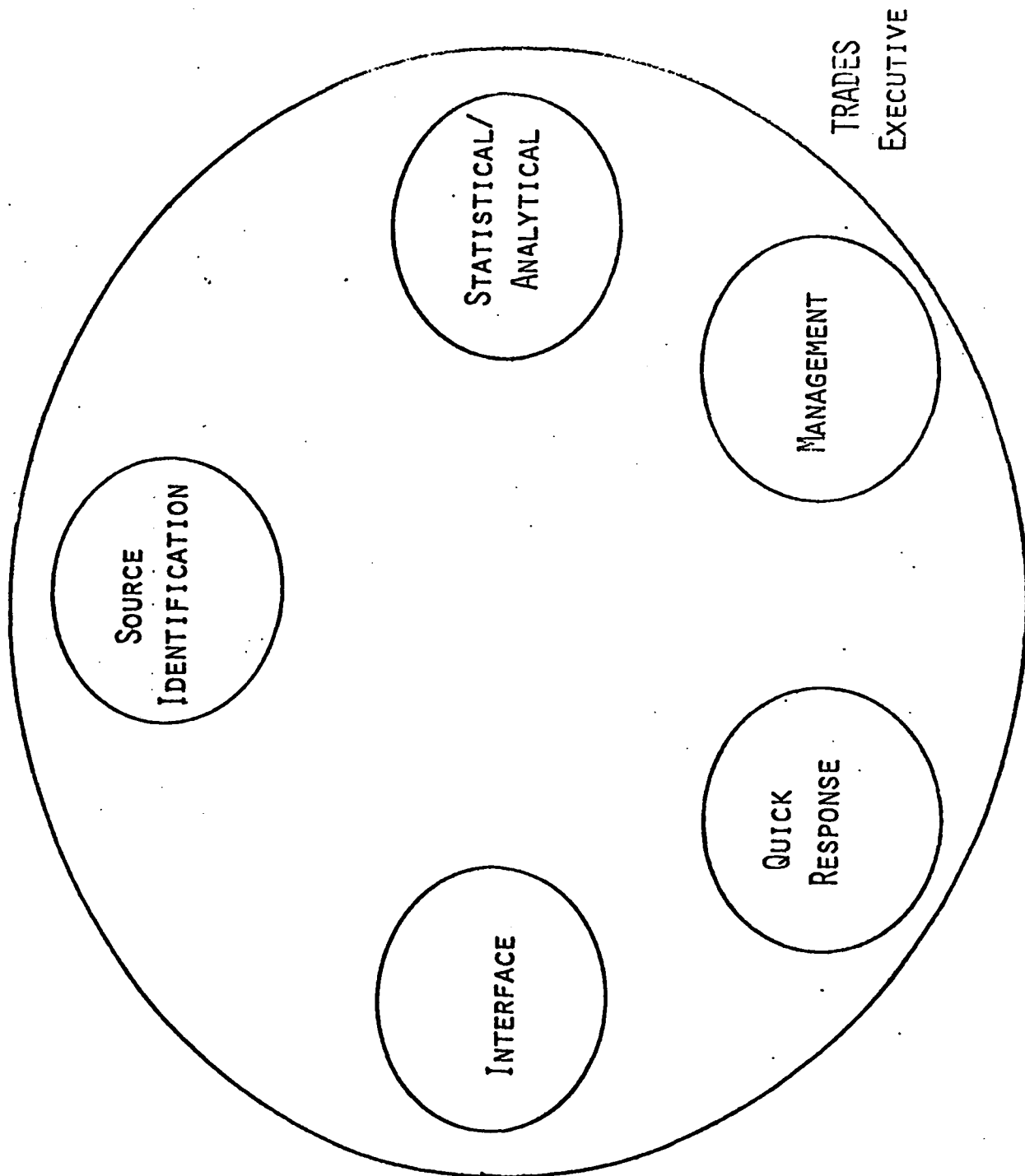maintenance effort to ensure interface capabilities
with other systems.

Figure 5-1. TRADES System Concept Module

TABLE 5-1. SOURCE IDENTIFICATION MODULE DESCRIPTION

o   Central repository of RAM data sources

o   Logical organization of taxonomy of commodities:

- End item

- Major Subsystems

- Selected Components

- Test and support equipment

Consistent with TM 38-750

o   Identifies:

- Agency with appropriate RAM data holdings

- Form of data (e.g., hard copy, automated, secure)

- Extent of holdings (e.g., years of information, numbers of reports)

- Form of data (e.g., test, raw field, reduced)

- Environmental condition (e.g., peacetime, geographical, arctic)

- Essential elements of information (EEI)

TABLE 5-2.   QUICK RESPONSE MODULE DESCRIPTION

o   Provides immediate "expected" value for each EEI by item identification, environment, and life cycle stage.

o   Values controlled by proponent activities.

TABLE 5-3.   INTERFACE MODULE DESCRIPTION

```
o  Protocol to communicate with source
   computers

o  Vehicle to extract, analyze, and format
   outputs from automated data sources
```

The Statistical/Analytical Module (Table 5-4) pro-
vides the user with a series of "tools" to analyze
raw data, or to combine the results of different
inputs to make the maximum proper inference and a
directly usable product for the RAM engineer.

.TABLE 5-4.   STATISTICAL/ANALYTICAL MODULE DESCRIPTION

```
o  Extract data

o  Formulate tables

o  Carry out regressions or time
   series analyses

o  Other statistical manipulations
```

The Management Module (Table 5-5) provides the abil-
ity for the TRADES Management Branch to monitor usage,
update the other modules, maintain historical records,
and provide control over the TRADES process.

TABLE 5-5.   MANAGEMENT MODULE DESCRIPTION

```
o  Provides basis for updating and developing
   other modules

o  Provides an audit trail of TRADES use

o  Provides proponents a method to record
   procedural notes.
```

TRADES REQUEST FLOW

Figure 5-2 illustrates a typical TRADES request flow, beginning with a user query. Information from the Source Identification Module directs the user to the Quick Response Module for an immediate "expected" value response, if that is desired (I). If reference is made to hard copy reports, information is provided on procedures to obtain them (II). In the event that RAM data is available in an external automated data base, the Interface Module serves to facilitate extraction of the required EEI and supporting information (III). In all cases, data may be processed using the Statistical/Analytical Module to determine needed values and relationships.

Additionally, the Management Module records each transaction to develop use frequency, audit trails and a historical file of outputs. The Management Module also provides the vehicle for update of the RAM information, program software and assistance to TRADES users.

PERSONNEL REQUIREMENTS

As a logical part of the implementing TRADES, consideration must be given to organizing a TRADES Management Branch within the USALOGC. This branch would have the following major functions:

1. TRADES system management
2. Methodological and analysis support
3. Source and user service.

Additionally, certain high volume users within TRADOC should have additional personnel assigned. These recommendations are based on anticipated proponency workload within the TRADES system.

Table 5-6 summarizes the total additional TRADOC personnel resources for TRADES implementation, noting location and job description.
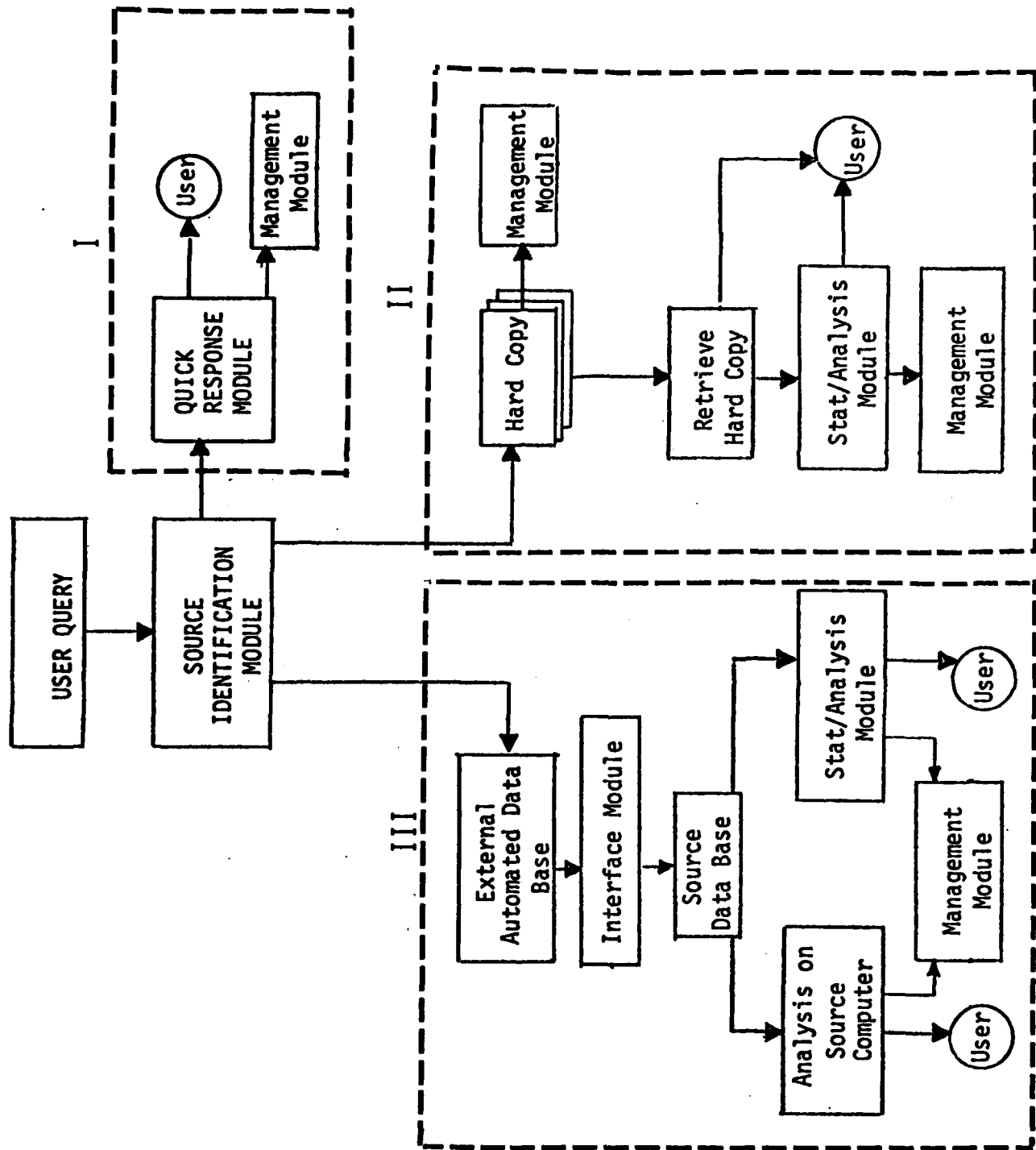
Figure 5-2. TRADES Request Flow

TABLE 5-6.   TOTAL TRADES TRADOC PERSONNEL REQUIREMENTS

USERS	DESCRIPTION	QTY
OCS	General Engineer (RAM)	1
TSCH	General Engineer (RAM)	1
MMCS	General Engineer (RAM)	1
FAS	General Engineer (RAM)	1
INS	General Engineer (RAM)	1
SIGS	General Engineer (RAM)	1
ENS	General Engineer (RAM)	1
AVNS	General Engineer (RAM)	1
ADS	General Engineer (RAM)	1
TRADES MANAGEMENT BRANCH (RAM/ILS DIV.)		
LOGC	Supervisory General Engineer (RAM)	1
LOGC	Analysts/Statisticians	2
LOGC	Computer Specialist (Sys Anl)	1
LOGC	General Engineer (RAM)	1
LOGC	Clerk Typist	1
DATA PROCESSING ELEMENT (Planning Factors Div.)		
LOGC	Senior Programmer	1
SOURCES		
No quantified estimates have been made.		
	TOTAL	16

While TRADES is expected to increase the efficiency of TRADOC RAM engineers, it is not likely that personnel reductions will occur as a result of TRADES. This is a preliminary estimate, subject to detail analysis during the TRADES implementation process.

HARDWARE REQUIREMENTS

The TRADES operating system is shown in Figure 5-3, as part of the PFDB system. The point has been made that TRADES capitalizes on sunk costs of both personnel and computer equipment programmed for the PFDB. Of the total system shown, the only equipment that would require separate purchase is approximately twenty terminals with line printers and multiplexers.
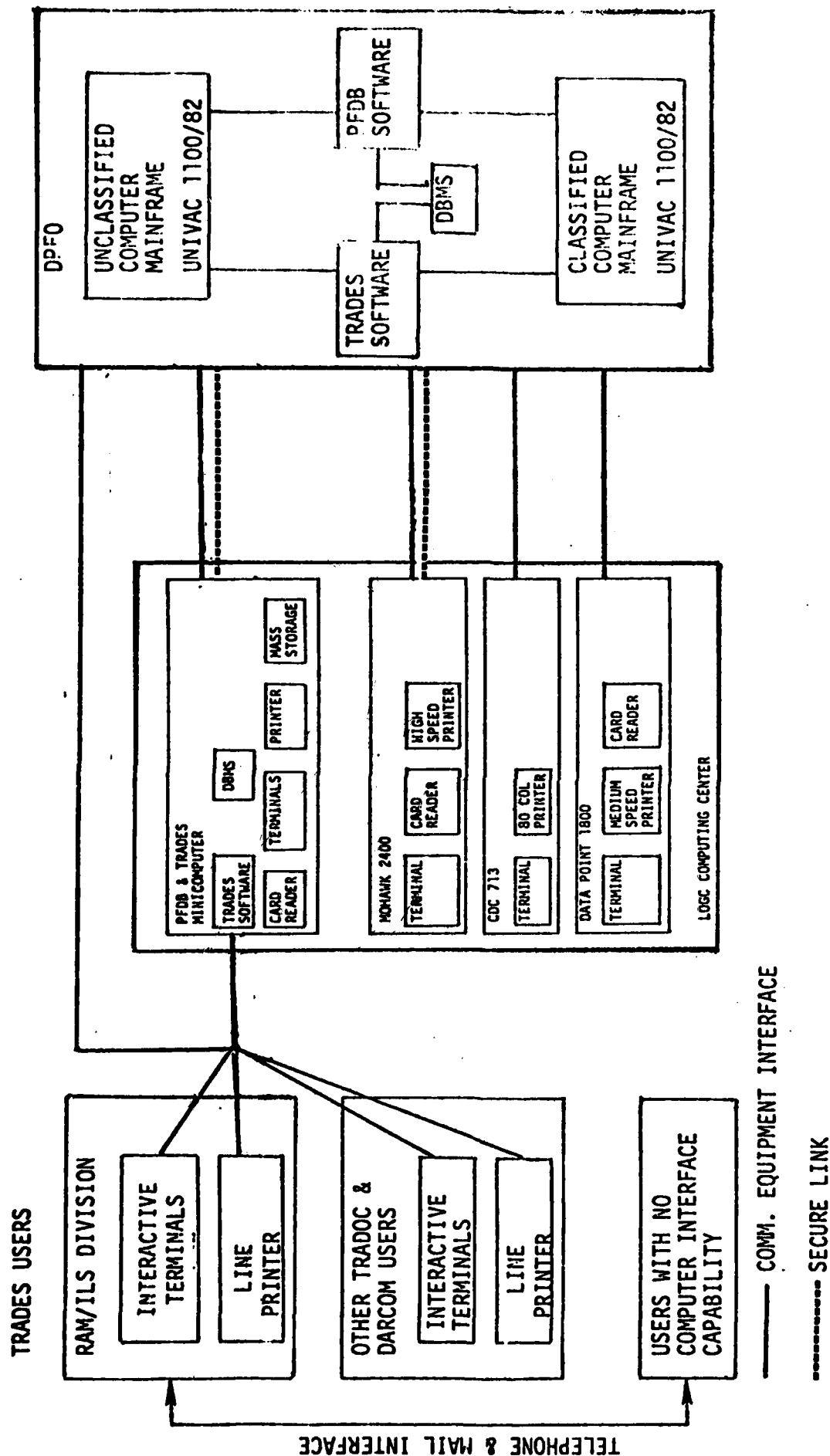
Figure 5-3. TRADES Alternative Concept of Operation (ACO) Using PFDB System

Other costs are minor, such as additional tapes or disks, and facilities requirements, such as desks. These have been identified in Parts IV (ACO) and V (STP). Table 5-7 lists the primary hardware items used by the TRADES system.

TRADES CAPABILITIES

The resulting capabilities of the TRADES system, as conceptualized, are summarized as follows:

1. Real-time access to automated data systems

2. Directory service for both automated and hard copy data

3. Rapid data reduction, analysis and manipulation

4. Historical record of output data provided.

TABLE 5-7. HARDWARE OVERVIEW

HARDWARE	CONCEPT CHARACTERISTICS
Mainframe	Time share with DPFO large mainframe computer with batch and interactive capability through terminals
Minicomputer	Utilizes a LOGC minicomputer with multiple terminals capability to handle processing and report dissemination. Estimated need of 2-4 MB of local memory
Line Printer	Use high speed line (600 LPM) printer located at LOGC Computing Center and with each remote terminal
Card Reader	Use 50-200 CPM Card Reader located at LOGC Computing Center
Tape Drives	Use 9-Track tape drives located at LOGC Computing Center and DPFO
Disk Drives	Use DPFOs and LOGC disk drives and disks for support of TRADES. Minimum of 90 MB storage capability initially
Microcomputers or Interactive Terminals	Use microcomputer and any interactive terminal with communications equipment for interactive operations
Security Equipment	Use in-place KG device for I/O transactions
Communications Equipment	Use a 4800 Baud dedicated line from the TRADES Office via the PFDB-TRADE minicomputer office to DPFO and other computer ports for interactive processing
Multiplexers	Asynchronous, minimum of eight (8) communications lines
Modems	Modems and cables as necessary for multiplexer requirement. Also needed with each terminal/mini-computer
Graphics Terminals	Graphics terminals and plotting equipment, preferably color systems, for requirements and performance charting

GLOSSARY

ACO	Alternative Concept of Operation
ADP	Automatic Data Processing
ADPE	Automatic Data Processing Equipment
ARA	Assigned Responsible Agency
COEA	Cost and Operational Effectiveness Analysis
COMRAM	Common RAM
CTDCS	Common Test Data Collection System
DBMS	Data Base Management System
DFSR	Detailed Functional System Requirements
DLSIE	Defense Logistics Services Information Exchange
DPFO	Data Processing Field Office
DT	Development Test
DTIC	Defense Technical Information Center
EEA	Essential Elements of Analysis
EEI	Essential Elements of Information
FP	Functional Proponent
FTS	Federal Telephone Service
ILS	Integrated Logistic Support
LOS	Logistics Oriented School
LSAR	Logistics Support Analysis Record
MP	Management Plan
MTBF	Mean Time Between Failure
MTBOMF	Mean Time Between Operational Mission Failure
MTBUMA	Mean Time Between Unscheduled Maintenance Actions
MTD	Maintenance Task Demand
MTTR	Mean Time to Repair
OAD	Operations Analysis Directorate
OT	Operational Test
OTEA	Operational Test and Evaluation Agency
PA	Proponent Agent
PFDB	Planning Factors Data Base
PFMD	Planning Factors Management Division
PM	Project Manager
PO	Project Officer
RAM	Reliability, Availability, Maintainability

(continued)

GLOSSARY (Concluded)

SAG   Study Advisory Group
SAMF   Stand-Alone Mainframe
SAMI   Stand-Alone Minicomputer
SAMS   Standard Army Maintenance System
SDC   Sample Data Collection
SDP   System Decision Paper
SRD   System Requirements Description
STP   System Technical Paper
SWP   Study Work Plan

TRADES   TRADOC RAM Data Evaluation System